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Alfalfa for The Yuma Mesa

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ALFALFA AND THE SOILS OF THE YUMA MESA

The Yuma Mesa is a terrace, or bench, from 5 to 15 miles wide and about 30 miles long, in the extreme southwestern corner of Arizona. It lies between the broad fertile valley of the lower Colorado River and the rocky hills east of the river and south of Yuma. Its soils are sterile and sandy. Extensive areas of similar lands extend throughout the lower Colorado region, but the Yuma Mesa is the first of such lands to be irrigated on a general scale. A small part of the Yuma Mesa irrigated first in 1924 has become a very successful citrus area. Another part of about 7,000 acres brought under irrigation in 1944 has been planted almost exclusively to alfalfa (fig. 1).

Until other crops are developed, alfalfa will be the most important one in this new area, not only because it provides valuable forage for both general feeding and cash sales, but also because of its effect on the soil and on following crops. A legume, alfalfa supplies its own nitrogen and ultimately enriches and ameliorates the harshness of the sandy, very nearly sterile Yuma Mesa soil.

Alfalfa seems to fit Yuma Mesa conditions. It is deep-rooted, allowing maximum use of the water that penetrates quickly and deeply into the very porous soil. It withstands high summer temperatures



FIGURE 1.—Alfalfa on the Yuma Mesa. This view, from the air, shows the unreclaimed Yuma Mesa desert (foreground) and a part of the area irrigated and planted to alfalfa. Stacks of baled hay are conspicuous along all the roads within the cultivated area.

well. It requires a high level of calcium in the root zone. And it will produce forage on a year-round basis where winter growing conditions are favorable, as they are in the lower Colorado region.

The soils of the Yuma Mesa belong in the Superstition series.¹ Those considered arable are characterized by 15 to 24 inches of very fine or loamy fine sand above a coarse permeable sand that makes up the bulk of the Mesa. These soils are naturally low in fertility with little organic matter or nitrogen. Available phosphorus is low. Free calcium carbonate is present throughout the whole profile, either dispersed and as concretions or coating other particles. This high calcium and the high pH, about 8.5, lead to nutritional deficiencies with some crops. Symptoms of these deficiencies have been described under the general term "lime-induced chlorosis."²

The amount of water a soil will hold after normal drainage is complete is called its field capacity. Good silt loams have field capacities of 25 to 35 percent water. The Yuma Mesa soils hold only 7 to 9 percent of water at field capacity. This low water-holding capacity means that frequent irrigations are necessary; it also means that in a very short time after a plant begins to need water it can be permanently injured for lack of it.

There is little clay in these Superstition sands. Base exchange is low, amounting to only 3 or 4 milliequivalents per hundred grams, compared with 25 or 30 for a good silty clay loam soil. A low base-exchange capacity is usually associated with incapacity for retaining

¹ YOUNGS, F. O., HARPER, W. G., THORP, J., and ISAACSON, M. R. SOIL SURVEY OF THE YUMA-WELLTON AREA, ARIZONA-CALIFORNIA. U. S. Bur. Chem. and Soils, Soil Survey Rpt., Ser. 1929, No. 20, 37 pp., illus. 1933.

² McGEORGE, W. T. A STUDY OF LIME-INDUCED CHLOROSIS IN ARIZONA ORCHARDS. Ariz. Agr. Expt. Sta. Tech. Bul. 117, pp. 341-388, illus. 1949.

plant food and fertilizer elements. Because of the frequent irrigation and the low fertility retention capacity of these soils, the leaching of nutrients assumes serious proportions.

CULTURE OF ALFALFA

SEEDBED PREPARATION

Land that has just been taken out of desert and is newly cleared and cultivated is usually ready for planting just as it lies, once the borders are up and the irrigation system is installed. On land previously cultivated, releveled may be required to eliminate inequalities and modify grades. For the Yuma Mesa, 660-foot runs with a grade of 2 or 3 feet per thousand have given good results.

It is important that each border check be irrigated with a uniform water cover. Inequalities increase rather than lessen with time, and a great deal of labor and water can be wasted in trying to cover high places in a border check. Expensive and ugly bare spots are one result of such areas inadequately watered.

Wherever borders are put in or renovated with a border disk, a furrow is left on each side of the ridge. These furrows form channels down which water speeds to flood the lower ends of fields before middles are properly irrigated. This quickly erodes the borders and causes breaks and uneven distribution. Check dams shoveled into the furrows help to control the erosion, but they require constant maintenance. It is far better to eliminate the furrows by building the borders with a scraper.

VARIETIES

FOR HAY.—The four hay varieties used on the Yuma Mesa are Hairy Peruvian, Chilean 21-5 (also known as Arizona Chilean), African, and Indian. African and Indian are Plant Introduction strains, first grown in this area at the United States Department of Agriculture Experiment Station at Bard, Calif., just across the river from Yuma. Both tend to make less summer and more winter growth than the other two varieties. This is of particular interest to potential livestock producers desiring year-round pasture supplies.

On the Yuma Mesa, highest annual production has come from African, with Hairy Peruvian only slightly lower. Indian does well for a year or so; then the yields fall off rapidly. The Chilean strains at first were the poorest of the four, but they exceeded the Indian within about 3 years. Chilean production, however, has not equaled that of the African or Peruvian strains.

FOR SEED.—In addition to the local hay varieties, seed has been produced from a number of out-of-State varieties. Certified seed from Buffalo, Ranger, and Atlantic alfalfas for use in the North and East has sold at a substantial premium on the Yuma market.

COMPANION CROPS

Alfalfa is usually seeded into or with another crop on the Yuma Mesa. This serves as a protection from the normally severe fall sandstorms. Sudan grass and barley have been most frequently used. Garden peas and vetch have also been tried, but there are indications

that vetch is not satisfactory as a companion crop for alfalfa. If seed is planted in late September or very early October, it may be possible to get a stand of alfalfa without a secondary crop, but the possibility of losing a seeding makes the attempt hazardous.

Land leveled in spring or summer has to be protected from wind erosion. Sudan grass will do this and also serve as a protection to the young alfalfa. It should be seeded at about 15 to 20 pounds per acre and fertilized lightly (about 15 pounds of nitrogen per acre), so that it will offer no serious competition to the alfalfa, which is drilled in the fields of Sudan grass in late September or early October.

If land is not ready before early fall, barley or peas may be planted with the alfalfa until as late as January. However, the earlier the alfalfa is planted, the better the stand is likely to be. Some cash return may be expected from either barley or peas, but barley as a grain crop requires more nitrogen fertilizer than when grown only to protect the alfalfa. Further, the loss of the first alfalfa hay crop may cost more than the grain is worth.

RATE AND DEPTH OF SEEDING

Alfalfa should be drilled about $1\frac{1}{2}$ inch deep in moist soil at a rate of 16 to 20 pounds per acre. If seed must be broadcast, it should be harrowed or very lightly disked in. The soil must be kept moist. It may be necessary to irrigate before emergence, to be sure of providing plenty of water.

FERTILIZER REQUIREMENTS

PHOSPHORUS

The initial phosphorus requirement for alfalfa on the Yuma Mesa is high. Large-scale experimental plantings have shown that, with superphosphate broadcast on new seedings on raw desert land, highest returns may be expected from an application of about 400 pounds P_2O_5 per acre, equivalent to 1 ton of 20-percent superphosphate. Smaller quantities may be applied over a period of 2 or 3 years, but best results cannot be expected until approximately 400 pounds of P_2O_5 have been put on the land. Once this initial requirement has been met, 100 pounds applied yearly or 200 pounds applied in alternate years should prove sufficient.

In experimental plantings on the Yuma Mesa (table 1) the first-year yields nearly doubled when the amount of phosphorus used was doubled. In 3 years, where no additions were made to the initial treatments, the return from the 200 pounds of P_2O_5 was half again as much as from the 100 pounds; and the return from 400 pounds was half again that from the 200 pounds. The returns in 1947 from 400 pounds applied as 200 pounds in 1946 and 200 pounds in 1947 were lower than those from the entire 400 pounds applied in 1946, but the returns in 1948 from the same applications were about the same. Apparently, more than 400 pounds P_2O_5 does not increase production until the second year after application. Data on this point are still being accumulated, but it is thought probable that such heavy initial applications will be beneficial.

TABLE 1.—*Total yields of alfalfa hay, 1946 to 1948, from different phosphate treatments in 1946 and 1947, on Yuma Mesa*

Initial P ₂ O ₅ applied per acre— 1946 (pounds)	P ₂ O ₅ added per acre— 1947	Total P ₂ O ₅ ¹	Yields per acre			
			1946	1947	1948	Total
	<i>Pounds</i>	<i>Pounds</i>	<i>Tons</i>	<i>Tons</i>	<i>Tons</i>	<i>Tons</i>
100 -----	None	100	1. 691	3. 362	3. 163	8. 216
100 -----	100	200	1. 691	5. 167	4. 460	11. 318
100 -----	200	300	1. 691	5. 890	5. 308	12. 889
200 -----	None	200	2. 993	5. 571	5. 185	13. 749
200 -----	100	300	2. 993	6. 777	5. 930	15. 700
200 -----	200	400	2. 993	7. 470	6. 500	16. 963
400 -----	None	400	5. 142	8. 231	6. 533	19. 906
400 -----	100	500	5. 142	7. 577	7. 978	20. 697
400 -----	200	600	5. 142	8. 739	8. 065	21. 946

¹ No fertilizer was applied to any plots during the 1948 season.

A number of ways of applying the fertilizer have been tried. Broadcast applications with a lime spreader have been customary, and the data in table 1 are from fields where the initial fertilizer applications were broadcast. Liquid phosphoric acid applied in irrigation water was tried, but, compared with solid forms, it was not nearly so productive for a new seeding. On an old established stand it was almost as good as the broadcast application.

Experimentally, drilling the phosphate in the row directly under the alfalfa seed, at a depth of about 3 inches, has been far superior to any other treatment in getting quick vigorous growth and early high yields from new seedings. If the fertilizer is drilled, the initial fertilizer requirement will be reduced. This, in turn, will reduce the initial cost in starting to grow alfalfa. Although a drill that would place the fertilizer beneath the alfalfa seed is badly needed, no commercial machine of this sort is known to the writer.

For the present, it is thought that the best way to fertilize an alfalfa seeding is to drill the fertilizer in one direction and the seed at right angles to it. Parallel seeding was tried; unless the seed was exactly over the fertilizer band, however, results were poorer than if the phosphate had been broadcast.

No experimental data are available for the fertilizer requirements of alfalfa on Yuma Mesa land that has been in cultivation and is being reseeded to alfalfa. An application of 150 to 200 pounds of P₂O₅ per acre at seedtime should prove about right.

A further check on phosphate-fertilizer supply can be made by the grower himself, using the spot-test method. Several areas on three or four border checks may be marked and additional fertilizer applied to them by hand broadcasting in late winter. If the alfalfa on these areas grows much larger and more luxuriantly than where only the regular applications of phosphate were made, it may be assumed that the regular applications have been too light.

The effect of secondary applications of phosphorus fertilizer on an established alfalfa stand is shown in figure 2. Just about three

times as much forage was produced on land receiving the addition of 150 pounds of P_2O_5 as on the land treated with only 50 pounds of P_2O_5 . This indicates also that the preliminary treatments had been far from adequate for the needs of the growing crop.



FIGURE 2.—Effect of additional phosphorus fertilizer on 3-year-old alfalfa: 20-percent superphosphate broadcast at the rate of 50 pounds of P_2O_5 per acre (right) and that applied at the rate of 150 pounds per acre (left).

NITROGEN

Because alfalfa is a legume, it can supply its own nitrogen if it is properly inoculated with efficient nitrogen-fixing bacteria. The mere presence of nodules does not insure this nitrogen fixation; there are legume bacteria which actually parasitize their hosts for this element. Nodules are formed, yet the alfalfa not only obtains no nitrogen from the activities of the bacteria it is supporting, but is robbed of some of the nitrogen needed for its own growth to supply the life processes of the parasitic bacteria.

To be sure of best results from inoculation, use a commercial culture and follow the manufacturer's directions. Store the inoculant in a cool place until it is used. Do not expose inoculated seed to direct sunlight; it may kill the bacteria. Drying and high temperatures also kill them or reduce their viability. Do not inoculate more seed at one time than can be planted within 1 to 2 hours. Inoculated seed may come in contact with phosphate fertilizer without damage to the bacteria, up to the point where seed is injured.

Some agricultural experiment stations report that a small amount of nitrogen used with alfalfa seed has produced increased yields because of the quick start it gave the young plants. Although nitrogen has been used experimentally with alfalfa seed on the Mesa, no beneficial results were observed.

POTASSIUM

In an experiment on the Yuma Mesa, potash added with phosphate fertilizer resulted in decreased hay yields. It is the writer's opinion that additional potash is not now required to grow alfalfa on the Mesa, and may never be.

OTHER NUTRIENT ELEMENTS

No deficiency diseases have yet been demonstrated for alfalfa on the Yuma Mesa. The problem of minor-element deficiencies is still under investigation, for the lack of an element or elements may occur at any time because of continued leaching and crop removal.

IRRIGATION

Experiments now in progress are expected to give information on minimum and ideal water requirements for alfalfa. Observations to date show that best yields will be obtained only if ample water is provided, particularly through the hottest part of summer. Possibly irrigations as often as once a week will be profitable through July, August, and early September. As the weather cools irrigations may be spaced as much as 2 to 3 weeks apart. Certainly alfalfa should never show wilting; that is an indication of too much moisture stress. Maximum growth ceases some time before wilting starts. Frequent light irrigations are better for the coarse-textured soils of the Yuma Mesa than more widely spaced heavy applications of water, because the top 4 feet of soil will hold only about 5 inches of water at best. More than that is lost by deep percolation, which not only wastes water but carries with it valuable dissolved food elements.

YIELDS AND MARKETING

HAY

Annual acre yields of 9 to 10 tons of alfalfa hay at 15 percent moisture have been recorded from experimental areas on the Yuma Mesa. They were obtained where ample phosphorus was applied, moisture supplies were kept up, harvests were promptly made, and the hay crop was removed immediately after each harvest. The general average for the Mesa is about 5 tons per acre per year.

Farm yields approaching the 9-ton-per-acre level should be possible with reasonable management. This entails a good phosphorus fertilizer program, adequate irrigation, and strict attention to harvesting so as to remove the hay crop promptly.

The time or stage of mowing is important. Cutting alfalfa too young will too often materially contribute to early stand losses. Cutting too late reduces hay quality and total yearly yield in the season following.^{3 4} Alfalfa is probably best mowed just before the new

³ GRABER, L. F., NELSON, N. T., LUEKEL, W. A., and ALBERT, W. B. ORGANIC FOOD RESERVES IN RELATION TO THE GROWTH OF ALFALFA AND OTHER PERENNIAL HERBACEOUS PLANTS. Wis. Agr. Expt. Sta. Res. Bul. 80, 128 pp., illus. 1927.

⁴ NELSON, M. MAINTENANCE OF ALFALFA STANDS. Ark. Agr. Expt. Sta. Bul. 447, 30 pp., illus. 1944.

basal shoots are long enough to be clipped or when the field is in about one-tenth bloom, whichever comes first. The basal-shoot development may be the best indicator early in the season; later it may be necessary to depend on blossom stage for cutting dates.

In the spring and fall hay is handled on the Yuma Mesa much as anywhere else in the United States, except for the fact that here drying is extremely rapid. It is common to cut one day, rake the same afternoon or the next morning, and bale with a pick-up baler the second day.

In the hot, dry summer, however, special harvesting techniques are necessary. Hay may be cut in the morning, raked into windrows within 2 to 3 hours, and be ready for baling by evening. Because of the extreme dryness, much baling is done at night to take advantage of whatever dew there may be. If hay gets too dry, so that the leaves shatter badly, or if there is no dew, the windrowed hay may be dampened with a portable fog sprayer ahead of the baler. With this treatment, care must be taken not to bale the hay so wet that it molds.

Once baled, the hay should be moved as soon as possible. This prevents spoilage in the bale and permits an early irrigation to bring on the next crop.

PASTURE

Alfalfa makes excellent pasture, and harvesting the crop by grazing eliminates the whole expensive procedure of cutting, raking, baling, and hauling. Consequently, much of the alfalfa on the Yuma Mesa has been pastured, largely by sheep shipped in from the range country, during winter. This method of crop removal may have the further advantage of adding manure to the land. Its disadvantages may be: Spread of weed seed by the livestock; damage to easily eroded canal banks by trampling; mechanical damage to alfalfa crowns from trampling, particularly by sheep.

ALFALFA MEAL

One alfalfa-meal plant on the Yuma Mesa and two in the Yuma area dry and grind the fresh green forage. Alfalfa for the drier is sold standing; harvesting is handled by the alfalfa-meal producers.

SEED

The production of alfalfa seed may be undertaken for two reasons. One is to insure a summer cash crop when the price of hay is low. This is particularly profitable when the grower can produce seed of premium quality either for local consumption or for eastern or northern seed houses. The other reason is to strengthen the stand and lengthen its duration. This effect results from the natural replanting that comes from dropped seed and from the increased vigor that results from increased food reserves accumulated in the roots after blooming is well under way.⁵

Seed yields of from 100 to 600 pounds per acre have been reported from the Yuma Mesa. Seed production there is so new that average

⁵ See footnotes 3 and 4, p. 7.

figures have not been established, but an average of around 250 pounds per acre or better seems possible. Where seed is the primary consideration, two crops are normally produced each season.

INSECTS AND DISEASES

INSECTS

The most serious alfalfa-hay insect pest is the alfalfa, or sulfur, butterfly. The adult is the familiar sulfur-yellow butterfly seen over most of the United States in late summer; the larvae are rather slender, pale-green worms that grow to about 1 or 1¼ inches in length just before pupating.

Eggs are laid in succulent young alfalfa, and the young grow rapidly and feed voraciously. Whole fields are so quickly stripped that nothing but gnawed stems are left by cutting time. Maximum damage occurs in August. Sometimes a partial crop may be saved by a quick clipping, regardless of stage of growth, if it is apparent that the worms will take it anyway. Very recently a new control for this insect has been successfully tried; it is a spray carrying a virus that attacks and kills the larvae at any stage of their development.

Other insects that may reduce yields somewhat are aphids and stinkbugs. Stinkbugs may become really serious on seed crops, so that they require control by dusting.

Two other insects—the lygus bug and the chalcid fly—are of real concern to the seed producer. The lygus bug, a yellow-brown insect about ¼ inch long, with a soft body and exposed wings, damages the seed crop by laying eggs in the flowering buds before they open, and so causing them to whiten and fall, and by feeding on them. Both adults and young are sucking insects and attack the growing tips and flower buds. When the flower buds are punctured, seed fails to develop. Lygus bugs are kept under control by the use of DDT dust. Experience has shown that finding 50 or 60 bugs per 100 sweeps of an insect net when the alfalfa is in bud or early-bloom stage calls for dusting to avoid serious loss.⁶

The chalcid fly is a small jet-black fly with reddish-brown legs and white wings, about the size of the smallest ants ordinarily seen around house foundations. It lays eggs in the immature seed pod. The tiny larvae live in individual seeds and eat the whole seed, leaving only the shell. They emerge through tiny pinholes in the seeds to start another generation. Frequently, because they are so small, their presence is not detected until the seed is threshed. Then more than half the crop may prove to consist of hollow seed. Control is difficult. DDT dusts are recommended, but they are only partially effective.

Good field sanitation, including the clean-up of all alfalfa plants on borders and in corners or edges, is of primary importance in reducing infestations of both the lygus bug and the chalcid fly. These pests build up rapidly from just a few parents. A thorough clean-up of infested fields, as well as careful management that includes the recommended application of dusts, may be essential for effective control.

⁶ MOODY, R. L. CONTROL OF LYGUS BUGS IN ALFALFA SEED FIELDS WITH DDT. Yuma Co. Agr. Ext. Off. Mim. 1948. [Processed.]

Caution.—Use proper precautions in applying the dusts or sprays. Otherwise, they may harm livestock and plants. Consult your country agricultural extension agent on the need for the sprays and dusts, on the quantities needed, and on how to apply them.

DISEASES

Alfalfa is subject to a number of diseases. The same diseases are present in nearly every large alfalfa-producing area in the United States. None is unique to the Yuma Mesa. Possibly the most serious on the Mesa is *Rhizoctonia* root canker, which is common throughout the hot, irrigated Southwest. Another disease which, it appears, could assume some importance in old stands is witches'-broom. Not much is known about this disease other than that it has been reported from many parts of the world and that it usually appears in older stands.

These diseases, with others, bring about rapid stand reduction, so that 5 years is considered the near-maximum life of the ordinary alfalfa field on the Yuma Mesa. When the plants become so few as to result in yield losses, reseeding or rotation becomes necessary.

There are no direct control measures for the common diseases. Losses can be reduced and stand life prolonged by making conditions right for most favorable growth. Good cultural practices call for good seed, plenty of good inoculant, adequate fertilizer, ample water, and careful harvesting. Weak plants are naturally more susceptible to injury; vigorous, strong plants resist the invasion of most diseases longer and more successfully.

SUMMARY

1. Alfalfa, because it provides its own nitrogen supply and is an outstanding soil improver and because it is unexcelled as a feed source, is an almost ideal crop for the Yuma Mesa.

2. Yuma Mesa soils need improving. They are sandy and low in fertility; hence they are best planted to leguminous crops unless expensive nitrogen fertilizers are applied in large quantities. Fortunately, the Yuma Mesa conditions and the alfalfa plant form an almost ideal team.

3. Four varieties of alfalfa have been recommended for the Yuma Mesa—African, Indian, Hairy Peruvian, and Arizona Chilean. Recent experiments on the Yuma Mesa show that African and Indian are characterized by greater winter growth than the others. African and Hairy Peruvian have given the highest annual yields. Chilean has been a low producer. Indian has not maintained stands.

4. Companion crops for the protection of new alfalfa seedlings are common. They may be summer plantings of Sudan grass in which alfalfa is seeded later, or they may be barley or peas planted at the same time as the alfalfa.

5. Alfalfa seed is planted at rates of 16 to 20 pounds to the acre, at a depth of $\frac{1}{2}$ inch. It should always be inoculated.

6. Heavy phosphate applications are necessary for good production, particularly on new land. It is suggested that for land not previously cropped about a ton an acre of 20-percent superphosphate (400 pounds of P_2O_5) be applied broadcast. A broadcast application of a

quarter of a ton of 20-percent superphosphate a year, or a half ton every second year, is believed necessary for maintenance of fertility.

7. Nitrogen, potassium, or minor elements such as boron and magnesium are apparently not necessary to the establishment and culture of alfalfa on the Yuma Mesa.

8. The water requirements of alfalfa are high. Crop reduction may be expected if the plants suffer for lack of water.

9. High hay yields are possible from the Yuma Mesa. Good management will be the key to annual yields of 9 tons or more of hay an acre. High phosphorus levels, ample moisture, and prompt harvesting at the right stage will be important.

10. Alfalfa is excellent pasture, and it may be profitable to plan to harvest at least a part of the crop by grazing. In the past, sheep have been extensively winter-grazed on Yuma Mesa alfalfa.

11. Alfalfa may also be marketed from the Yuma Mesa through the alfalfa-meal plants established in the area.

12. Seed may be produced for a cash crop or to increase and invigorate stands. Two seed crops a year are common where seed is the primary objective.

13. The alfalfa, or sulfur, butterfly is a serious pest in hay production. Lygus bugs and stinkbugs may seriously damage seed production, but control is possible. Chalcid fly also seriously reduces seed yields; its control is difficult. Good field sanitation is the cheapest and one of the best contributors to insect control.

14. Diseases are common. Control consists of maintaining vigorous stands.

